

17 - 19 October 2025

Lyon , France

From Theory to Practice: Assessing a Hands-On PINN Activity in a Biomechanics Engineering Course

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Abstract

The integration of advanced computational methods like Physics-Informed Neural Networks (PINNs) into undergraduate engineering curricula presents a significant pedagogical challenge. This study details an educational project designed to introduce PINN concepts within a Continuum Biomechanics course. A voluntary, hands-on activity was conducted with 36 undergraduate students. Using MATLAB, students implemented a PINN to solve two distinct physical systems: a non-linear advection-reaction PDE modeling tumor growth and a second-order ODE for damped vibrations. The activity's effectiveness was quantitatively and qualitatively assessed through pre- and post-questionnaires evaluating conceptual understanding and student perception. The analysis revealed a substantial learning gain. Understanding of core technical concepts showed dramatic improvement; for instance, correct identification of the role of non-linear activation functions rose from 17% to 82%. Similarly, comprehension of collocation points increased from 33% to 72%. Student feedback was overwhelmingly positive, with 95% reporting the activity as a significant learning experience and 87% feeling highly motivated. The results demonstrate that a practical, problem-based approach is a highly effective strategy for teaching the complex mechanisms of PINNs. This methodology provides a validated template for incorporating cutting-edge AI/ML topics into traditional engineering courses, successfully bridging the gap between abstract theory and practical application while enhancing student competence and engagement.

Keywords: Biomechanics; Computational Simulation; Educational Innovation; Engineering Education; Physicsinformed-informed Neural Networks (Pinns)